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Abstract

SOME NEW ASPECTS OF USING ADJOINT FUNCTIONS AND PERTURBATION THEORY IN REACTOR AND SHIELDING CALCULATIONS

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Some aspects of applications of adjoint equations to investigate some reactor and radiation shielding problems are presented.

In this report a new application of perturbation theory recently developed by one of the authors (Atomnaya Energfya, No.12, 1963) is considered in which one can obtain not only reactivity changes but also variations of a number of other reactor characteristics represented as a ratio of any two values of neutron-induced processes in reactor. Among such values one can mention for example a breeding ratio. Computation algorithm is described and some applications of this perturbation theory are given.

In this report adjoint equations and perturbation theory technique are applied to find minima of reactor critical mass in general case. Conception of efficiency function of fission material in reactor is introduced. Constancy of this function within reactor core is shown to be the condition of reactor critical mass to be minimum. The algorithm of numerical calculations of minimum critical mass based on iterations with the efficiency function of fission material having a constant value is discussed. Material efficiency conception in reactor and corresponding algorithm for the determination of this optimal distribution of material can be extended to other reactor materials (for example, moderator, absorber, U^{238} distribution in breeder reactor).

In addition to the above-mentioned applications of adjoint equations to reactor problems the applications of non-homogeneous adjoint equations to investigation and design of radiation shielding are also considered. Physical meaning of the adjoint function as hazard function for neutrons with regard to processes in

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shielding is shown. The perturbation theory formulae for the most general case of medium and source parameter changes are derived.

Efficiency function conception of shielding material for various processes in shielding is introduced.

The condition of optimal shielding material distribution is formulated on the basis of mentioned efficiency function concertion.